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Box Patent Application
Assistant Commissioner for Patents
Washington, D.C. 20231

New U.S. Patent Application
Title: RETRIEVAL DEVICE
being a Continuation of PCT International
Application No. PCT/IE00/00097, filed August 11, 2000
Inventors: David VALE, Paul GILSON, and Patrick GRIFFIN

Dear Sirs:

We enclose the following papers for filing in the United States Patent and Trademark Office under 35 U.S.C. 111(a) as a **Continuation** application of PCT International Application No. PCT/IE00/00097, filed August 11, 2000, which claimed priority of International Patent Application No. PCT/IE99/00082, filed August 12, 1999.

1. Application 26 pages, including 2 independent claims and 46 claims total (as amended).
2. Preliminary Amendment.
3. Drawings 9 sheets of drawings containing 34 figures.
4. Declaration and Power of Attorney
5. Recordation Form Cover Sheet and Assignment to Salviac Limited.
6. Certified copy of International Application No. PCT/IE99/00082, filed August 12, 1999.
7. Information Disclosure Statement and Information Disclosure Citation, PTO 1449 with documents attached.
8. The filing fee is calculated as follows:



Basic Application Filing Fee					\$740	\$740.00
	Number of Claims		Basic	Extra Claims		
Total Claims	46	-	20	26	x \$18	468.00
Independent Claims	2	-	3	0	x \$84	
<input type="checkbox"/> Presentation of Multiple Dep. Claim(s)					+\$280	
Subtotal						\$ 1208.00
Reduction by ½ if small entity						-
TOTAL APPLICATION FILING FEE						\$ 1208.00

9. A check for \$1248.00 is enclosed. The fee includes:

\$740.00 filing fee;
\$468.00 additional claims fee; and
\$40.00 Assignment recordation fee.

10. Copy of cover page of WIPO Publication No. WO01/12082A1.

Applicants claim the right to priority based on International Application No. PCT/IE99/00082, filed August 12, 1999.

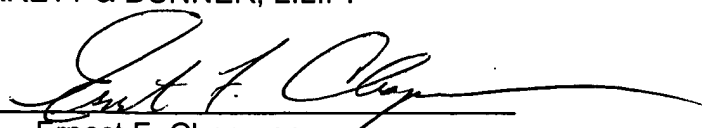
Please address all correspondence with respect to this application to:

Finnegan, Henderson, Farabow, Garrett & Dunner, L.L.P.
1300 I Street, N.W.
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Please accord this application a serial number and filing date and record and return the Assignment to the undersigned.

The Commissioner is hereby authorized to charge any additional filing fees due and any other fees due under 37 C.F.R. § 1.16 or § 1.17 during the pendency of this application to our Deposit Account No. 06-0916.

Sincerely,
FINNEGAN, HENDERSON, FARABOW,
GARRETT & DUNNER, L.L.P.

By: 
Ernest F. Chapman
Reg. No. 25,961

EFC/peg
Enclosures



Patents Office
Government Buildings
Hebron Road
Kilkenny

I HEREBY CERTIFY that annexed hereto is a true copy of documents filed in connection with the following patent application:

Application No. PCT/IE99/00082

Date of Filing 12 August 1999

Applicant SALVIAC LIMITED, an Irish company of 39-40 Upper Mount Street, Dublin 2, Ireland

Dated this 18 day of September, 2000.



An officer authorised by the
Controller of Patents, Designs and Trademarks.

PCT

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

PCT/IE 99 / 00082

International Application No.

12 AUG 1999

International Filing Date

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference

(if desired) (12 characters maximum) SALV15/C/WO

Box No. I TITLE OF INVENTION

Retrieval Device

Box No. II APPLICANT

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

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Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

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agent

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common representative

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☒ applicant and inventor
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This person is:

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☐ applicant and inventor
☐ inventor only (If this check-box is marked, do not fill in below.)

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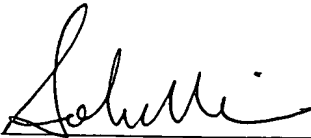
Regional Patent

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Box No. VI PRIORITY CLAIM				
<input type="checkbox"/> Further priority claims are indicated in the Supplemental Box.				
Filing date of earlier application (day/month/year)	Number of earlier application	Where earlier application is:		
		national application: country	regional application: regional Office	international application: receiving Office
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item (2)				
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<input type="checkbox"/> The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) (only if the earlier application was filed with the Office which for the purposes of the present international application is the receiving Office) identified above as item(s):				
<small>* Where the earlier application is an ARIPO application, it is mandatory to indicate in the Supplemental Box at least one country party to the Paris Convention for the Protection of Industrial Property for which that earlier application was filed (Rule 4.10(b)(ii)). See Supplemental Box.</small>				
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Choice of International Searching Authority (ISA) <small>(if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):</small>		Request to use results of earlier search; reference to that search (if an earlier search has been carried out by or requested from the International Searching Authority):		
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Box No. VIII CHECK LIST; LANGUAGE OF FILING				
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request : 4		1. <input checked="" type="checkbox"/> fee calculation sheet		
description (excluding sequence listing part) : 11		2. <input type="checkbox"/> separate signed power of attorney		
claims : 5		3. <input checked="" type="checkbox"/> copy of general power of attorney; reference number, if any:		
abstract : 1		4. <input type="checkbox"/> statement explaining lack of signature		
drawings : 5		5. <input type="checkbox"/> priority document(s) identified in Box No. VI as item(s):		
sequence listing part of description :		6. <input type="checkbox"/> translation of international application into (language):		
Total number of sheets : 26		7. <input type="checkbox"/> separate indications concerning deposited microorganism or other biological material		
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Figure of the drawings which should accompany the abstract: 1		Language of filing of the international application: English		
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 John O'Brien				

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1. Date of actual receipt of the purported international application: 12 AUG 1996	2. Drawings:
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:	<input checked="" type="checkbox"/> received:
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"A Retrieval Device"Introduction

5

The invention relates to a retrieval device for retrieving a medical device from a body lumen. More particularly, the retrieval device may be used for retrieving an embolic filter device deployed in the vasculature of a patient to provide protection against embolic material dislodged during a surgical or medical procedure. Such an embolic protection device is described in our WO 99/23976A.

10

To retrieve a deployed medical device such as an embolic filter from a body lumen a retrieval catheter is used. The catheter is in the form of an elongated tube with an open mouth at the distal end into which the deployed device is retrieved. There is however a problem with such retrieval catheters in that the open mouth can become snagged at sharp changes in direction in the body lumen, at stenosed regions, or on other deployed medical devices such as stents. This is particularly the case with an embolic filter or other distal protection device which is deployed downstream of a stenosis during an angioplasty. A stent is usually deployed in the region of the stenosis and on completion of the procedure the stenosed region and the stent must be traversed by the open mouth of the retrieval catheter to retrieve the embolic filter.

15

20

There is therefore a need for an improved retrieval device which will overcome this problem.

25

Statements of Invention

30

According to the invention there is provided a retrieval device for retrieving a medical device from a body lumen, the retrieval device comprising a retrieval catheter having an elongate tube with an open mouth at a distal end thereof to

- 2 -

receive a medical device on retrieval and a centring catheter for guiding the open mouth of the retrieval catheter through the body lumen to avoid obstructions in the lumen.

5 In one embodiment of the invention the centring catheter has a distal end which is tapered to guide the retrieval catheter through the lumen. The distal end of the centring catheter is preferably movable from an advancement mode in which it projects from the distal end of the retrieval catheter, to a retrieval position in which it is retracted into the retrieval catheter proximally of the distal end of the
10 retrieval catheter.

In another embodiment of the invention the centring catheter comprises an elongate tubular member extending through the retrieval catheter, the tubular member being slidably movable from an advancement mode to a retracted
15 retrieval position.

In a further embodiment of the invention the proximal end of the centring catheter extends from the retrieval catheter for external manipulation of the centring catheter relative to the retrieval catheter.
20

In a preferred embodiment of the invention the centring catheter has a bore extending at least partially along its length for threading the retrieval device over a guidewire. The centring catheter positions the guidewire centrally in the lumen away from the vessel walls.
25

Preferably the distal end of the centring catheter is at least partially radiopaque. The centring catheter is preferably of a material with a low coefficient of friction.

In one embodiment of the invention the retrieval catheter has a radially expandable tip to accommodate a retrieved medical device. Preferably the retrieval catheter
30 tip has sufficient axial stiffness to assist the pull back of a medical device.

- 3 -

The centring catheter may be removable from the retrieval device.

5

In another preferred embodiment of the invention the distal end of the centring catheter is shaped to provide a step free transition between the distal end of the centring catheter and the tip of the retrieval catheter. The distal end of the centring catheter is preferably shaped as an arrowhead.

10

Preferably the distal end of the centring catheter is compressible.

In a further preferred embodiment of the invention the distal end of the centring catheter is sealable to the tip of the retrieval catheter.

15

In another embodiment of the invention the diameter of the retrieval catheter varies along its length.

Typically the medical device is an embolic filter device.

20

In a particularly preferred embodiment of the invention the inner surface of the retrieval catheter and/or the outer surface of the centring catheter is of non-circular profile. The catheter periphery is preferably non-circular. For example, the catheter periphery is of oval shape.

25

Alternatively the catheter periphery is shaped to define a number of separate areas of contact with the other catheter. In this preferably the catheter periphery is of fluted shape.

30

In another aspect the invention provides a method for retrieval of a medical device from a body lumen comprising the steps of:-

- 4 -

introducing a retrieval catheter and a centring catheter over a guidewire so that the distal end of the centring catheter projects from the distal end of the retrieval catheter;

5 advancing the centring catheter and the retrieval catheter proximally to the medical device;

 withdrawing the distal end of the centring catheter into the retrieval catheter;

10 withdrawing the medical device into the retrieval catheter; and

 removing the retrieval device from the body lumen.

15 In one embodiment of the invention the method includes the step of flushing and/or aspirating before withdrawing the medical device into the retrieval catheter.

 In another embodiment of the invention the method includes the step of removing
20 the centring catheter from the retrieval catheter to facilitate flushing and/or aspiration.

 Preferably the distal end of the centring catheter is compressed as the distal end of the centring catheter is withdrawn into the retrieval catheter.

25 In another aspect the invention provides a catheter assembly comprising an inner catheter, and an outer catheter surrounding the inner catheter wherein the inner surface of the outer catheter and/or the outer surface of the inner catheter is of non-circular profile.

30 In one embodiment of the invention the catheter periphery is non-circular.

- 5 -

Preferably the catheter periphery is of oval shape.

5 In another embodiment of the invention the catheter periphery is shaped to define a number of separate areas of contact with the other catheter. In this case, the catheter periphery may be of fluted shape.

Brief Description of the Drawings

10

The invention will be more clearly understood from the following description thereof given by way of example only, in which:-

15

Fig. 1 is a side view of a retrieval device according to the invention;

Fig. 2 is a perspective partially cut-away view of the retrieval device of Fig. 1, in use;

20

Figs. 3(a) to 3(d) are side partially cut-away views of the retrieval device of Fig. 1 in different positions of use;

Fig. 4 is a diagrammatic view of the retrieval device of Fig. 1 in use;

25

Fig. 5 is a side cross sectional view of a distal end detail of another retrieval device according to the invention;

Fig. 6 is a side cross sectional view of the retrieval device of Fig. 5 in an advancement mode;

30

Fig. 7 is a side cross sectional view of a distal end detail of a further retrieval device according to the invention;

- 6 -

Fig. 8 is a side cross sectional view of a distal end detail of another retrieval device according to the invention;

5 Fig. 9 is a perspective partially cut-away view of a detail of a catheter assembly of the invention;

Fig. 10 is a perspective partially cut-away view of a detail of another catheter assembly of the invention; and

10

Fig. 11 is a cross sectional end view of a detail of another catheter assembly of the invention.

Detailed Description

15

Referring to Figs. 1 to 4 there is illustrated a retrieval device according to the invention and indicated generally by the reference numeral 1. The retrieval device 1 is used for retrieval of a medical device such as an embolic filter 2 from a body lumen such as the vasculature 3. The embolic filter 2 is of the type described in
20 our WO 99/23976A, the entire contents of which are incorporated herein by reference.

In use a guide catheter 42 (Fig. 4) extends through the body lumen 3 proximal to the stenosed region. The guide catheter 42 comprises an elongate tube 43 housing
25 a proximal end and a distal end. The distal end has an open mouth 46. To retrieve the embolic filter 2 a retrieval device 1 is advanced through the guide catheter 42. The retrieval device 1 comprises a retrieval catheter 10 and a centring catheter 11.

30 The retrieval catheter 10 comprises an elongate flexible tube 15 having a proximal end 16 external of the lumen and fitted, for example with a Y-connector and a

- 7 -

5 Tuohy Borst adapter. The retrieval catheter 10 extends through the guide catheter 42 and terminates beyond the distal end thereof. A distal end 18 of the retrieval catheter has an expansible tip 19 with an open mouth 40 to accommodate the embolic filter. The retrieval catheter and filter are described in detail in our WO 99/23976A and PCT/IE 99/00021.

10 The centring catheter 11 comprises an elongate tube 20 which extends through the retrieval catheter tube 15 and terminates beyond the distal end 18 thereof in a soft, flexible tapered end 21. A proximal end 22 of the centring catheter 11 extends from the body lumen for external manipulation of the centring catheter 11. In this case the centring catheter tube 20 has a central bore for threading over a guidewire 25 to which the filter 2 is mounted. The bore may extend partially along the length of the centring catheter 11 to provide for rapid exchange. For ease of location, preferably the soft, distal end 21 of the centring catheter 11 is at least partially of, or coated with, a radiopaque material. The centring catheter 11 is of a suitable low friction material for smooth slidable travel through the retrieval catheter 10. A particularly suitable material for the centring catheter 11 would be a high density polyethylene/low density polyethylene (HDPE/LDPE) mix.

20 The tapered distal end 21 of the centring catheter tube 20, in use, projects from the open mouth 40 of the retrieval catheter 10 to provide a smooth, step-free crossing profile. The soft, tapered distal end 21 allows the retrieval catheter 10 to be smoothly advanced through the vasculature 3 without becoming snagged on a partial blockage such as a region 30 of stenosis, on a deployed stent 33, or in stenosed regions 31, 32 adjacent to the stent 33.

30 To collapse the filter 2 after use and retrieve it from the body lumen 3, the retrieval catheter 10 is introduced over the guidewire 25 to which the filter 2 is distally mounted, and with the aid of radiopaque markers, the filter 2 is urged into the retrieval catheter 10 by pulling the filter guidewire 25 proximally. The tip 19 of the retrieval catheter 10 is radially flexible/expansible to accommodate the

- 8 -

embolic bulk that the filter 2 may have retained, but also has enough axial stiffness to assist the pull back of the filter 2 into the tip 19.

Referring in particular to Figs. 3(a) to 3(d), in an advancement mode the tapered distal end 21 of the centring catheter tube 20 projects from the open distal end 18 of the retrieval catheter 10 over the guidewire 25. When the retrieval catheter 10 has been advanced so that the distal end 21 of the centring catheter tube 20 is in a position adjacent the proximal end of the filter 2, the tapered end 21 of the centring catheter tube 20 is retracted proximally into at least a portion of the retrieval catheter 10, exposing the open mouth 40 of the retrieval catheter 10. The filter 2 is then collapsed and retrieved into the expansible tip 19 of the retrieval catheter 10. The retrieval catheter 10 with the retrieved filter 2 in place is then withdrawn through the lumen 3.

Referring now to Figs. 5 and 6 in another embodiment of the invention, the distal end of the centring catheter tube 20 is in the shape of an arrowhead 50. The largest outer diameter d_1 of the distal end 50 of the centring catheter tube 20 is equal to the outer diameter d_2 of the retrieval catheter tip 19 at the open mouth 40. This ensures that there is a step free transition between the centring catheter distal end 50 and the retrieval catheter tip 19 in the advancement mode of Fig. 6. The distal end 50 of the centring catheter tube 20 is of a soft, flexible material, and is hollow. The distal end 50 is compressible, and may be compressed into a smaller diameter by pulling the centring catheter 11 back into the retrieval catheter 10 in the longitudinal direction. This enables the smooth pull back of the centring catheter 11 into the tip 19 of the retrieval catheter 10. Pull back of the centring catheter 11 is further assisted by the axial stiffness of the tip 19 of the retrieval catheter 10. The distal end 50 of the centring catheter tube 20 sealingly engages the retrieval catheter tip 19 in the advancement mode. This enables a centring catheter 11 with a small tube diameter to be used, thus providing more lumen space within the retrieval catheter 10 to facilitate flushing and/or aspiration.

Referring now to Fig. 7 in another embodiment of the invention the diameter of the retrieval catheter 10 varies along its longitudinal length. In this case the diameter d_t of the tip 19 of the retrieval catheter 10 is greater than the diameter d_c of the remaining length of the retrieval catheter 10. The diameter d_t of the tip 19 of the retrieval catheter 10 is equal to or greater than the diameter d_g of the guide catheter 42. This allows a retrieval catheter tube 15 of smaller diameter to be used, thus providing more lumen space within the guide catheter 42. This extra lumen space enables the injection of contrast media and the like through the guide catheter 42.

Referring to Fig. 8 there is illustrated another retrieval device 41 according to the invention, which is similar to the retrieval device 1 described above and like parts are assigned the same reference numerals. In this case the retrieval catheter is provided by a guide catheter 60 and a separate retrieval catheter is not required. The guide catheter 60 is of sufficiently small diameter to allow it to be advanced to the site of the stenosis, and the centring catheter 11 in the shape of an arrowhead is sized to match the outer diameter of the guide catheter 60 allowing it to slide therein.

In another embodiment of the invention, the outer diameter of the centring catheter 11 is the same as the inner diameter of the guide catheter 60. This ensures that smooth transition is provided between the guide catheter 60 and the centring catheter 11.

The invention provides a retrieval system, which is simple to operate and yet provides snag-free manipulation of a retrieval catheter to a retrieval site. A smooth crossing profile is provided with a tapered transition to enable the retrieval catheter to pass through the diseased vessel and through the stent without gouging the vessel, without catching on or dislodging the stent and without scraping or dislodging embolic material from the wall of the vessel or stent.

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The centring catheter 11 also provides support to the retrieval catheter assembly, greatly enhancing the integrity and kink resistance of the system, so that an ultra low profile, thin wall retrieval catheter 10 can be used. This means that a very large lumen can be provided to facilitate the retrieval of the largest filter sizes with large volumes of captured embolic material.

The centring catheter 11 also maintains the guidewire 25 positioned towards the centre of the lumen 3 and away from the walls of the lumen 3. This minimises the contact between the guidewire 25 and the walls of the lumen 3.

The invention has been described in relation to a carotid angioplasty procedure with an intravascular filter being placed distally to capture any emboli being released during the procedure. However, it may be applied to other medical procedures such as angioplasty and stenting of surgically implanted Saphenous Vein grafts that have stenosed, or primary treatment of renal artery stenoses. Indeed, the invention is applicable to the retrieval of embolic protection devices to protect patients during any vascular intervention. The invention may also be used for the retrieval of other medical devices, especially where there is a requirement for safe retrieval through an implanted stent.

Preferably the retrieval device 1 includes means to facilitate flushing and/or aspiration. In one embodiment of the invention, the centring catheter 11 may be withdrawn fully from the retrieval catheter 10, to facilitate flushing and/or aspiration.

Referring to Figs. 9 to 11 there are illustrated alternative centring catheters 11 with non-circular cross sections to facilitate flushing and/or aspiration without requiring the centring catheter 11 to be removed from the retrieval catheter 10. The non-circular cross section also reduces the area of contact between the centring catheter 11 and the retrieval catheter 10, thereby reducing the frictional

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force acting between the outer surface of the centring catheter tube 20 and the inner surface of the retrieval catheter tube 15.

5 Referring in particular to Fig. 9 in this case the centring catheter 11 is of a generally oval cross section. This creates defined passageways 61 between the retrieval catheter 10 and the centring catheter 11.

10 In the arrangement illustrated in Fig. 10 there are five contact points with the retrieval catheter and again defined passageways 62 are created.

The fluted arrangement of Fig. 11 is preferred because defined passageways 63 are created between the flutes 64 while ensuring a large lumen space between the centring catheter 11 and the retrieval catheter 10.

15 It will be appreciated that the non-circular catheter periphery may be applied to any catheter assembly which includes an outer catheter surrounding an inner catheter.

20 The invention is not limited to the embodiments hereinbefore described, which may be varied in detail.

Claims

1. A retrieval device for retrieving a medical device from a body lumen, the retrieval device comprising a retrieval catheter having an elongate tube with an open mouth at a distal end thereof to receive a medical device on retrieval and a centring catheter for guiding the open mouth of the retrieval catheter through the body lumen to avoid obstructions in the lumen.
5
2. A retrieval device as claimed in claim 1 wherein the centring catheter has a distal end which is tapered to guide the retrieval catheter through the lumen.
10
3. A retrieval device as claimed in claim 1 or 2 wherein the distal end of the centring catheter is movable from an advancement mode in which it projects from the distal end of the retrieval catheter, to a retrieval position in which it is retracted into the retrieval catheter proximally of the distal end of the retrieval catheter.
15
4. A retrieval device as claimed in any preceding claim wherein the centring catheter comprises an elongate tubular member extending through the retrieval catheter, the tubular member being slidably movable from an advancement mode to a retracted retrieval position.
20
5. A retrieval device as claimed in any preceding claim wherein the proximal end of the centring catheter extends from the retrieval catheter for external manipulation of the centring catheter relative to the retrieval catheter.
25
6. A retrieval device as claimed in any preceding claim wherein the centring catheter has a bore extending at least partially along its length for threading the retrieval device over a guidewire.
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7. A retrieval device as claimed in any preceding claim wherein the centring catheter positions the guidewire centrally in the lumen away from the vessel walls.
- 5 8. A retrieval device as claimed in any preceding claim wherein the distal end of the centring catheter is at least partially radiopaque.
9. A retrieval device as claimed in any preceding claim wherein the centring catheter is of a material with a low coefficient of friction.
- 10 10. A retrieval device as claimed in any preceding claim wherein the retrieval catheter has a radially expandable tip to accommodate a retrieved medical device.
- 15 11. A retrievable device as claimed in any preceding claim wherein the retrieval catheter tip has sufficient axial stiffness to assist the pull back of a medical device.
- 20 12. A retrieval device as claimed in any preceding claim wherein the centring catheter is removable from the retrieval device.
- 25 13. A retrieval device as claimed in any preceding claim wherein the distal end of the centring catheter is shaped to provide a step free transition between the distal end of the centring catheter and the tip of the retrieval catheter.
14. A retrieval device as claimed in claim 13 wherein the distal end of the centring catheter is shaped as an arrowhead.
- 30 15. A retrieval device as claimed in claim 13 or 14 wherein the distal end of the centring catheter is compressible.

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16. A retrieval device as claimed in claims 13 to 15 wherein the distal end of the centring catheter is sealable to the tip of the retrieval catheter.
- 5 17. A retrieval device as claimed in any preceding claim wherein the diameter of the retrieval catheter varies along its length.
18. A retrieval device as claimed in any preceding claim wherein the medical device is an embolic filter device.
- 10 19. A retrieval device as claimed in any preceding claim wherein the inner surface of the retrieval catheter and/or the outer surface of the centring catheter is of non-circular profile.
- 15 20. A retrieval device as claimed in claim 19 wherein the catheter periphery is non-circular.
21. A retrieval device as claimed in claim 19 or 20 wherein the catheter periphery is of oval shape.
- 20 22. A retrieval device as claimed in claims 19 to 21 wherein the catheter periphery is shaped to define a number of separate areas of contact with the other catheter. }
- 25 23. A retrieval device as claimed in claims 19 to 22 wherein the catheter periphery is of fluted shape.
24. A retrieval device substantially as hereinbefore described with reference to the accompanying drawings.
- 30 25. A method for retrieval of a medical device from a body lumen comprising the steps of:-

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introducing a retrieval catheter and a centring catheter over a guidewire so that the distal end of the centring catheter projects from the distal end of the retrieval catheter;

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advancing the centring catheter and the retrieval catheter proximally to the medical device;

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withdrawing the distal end of the centring catheter into the retrieval catheter;

withdrawing the medical device into the retrieval catheter; and

15

removing the retrieval device from the body lumen.

26. A method as claimed in claim 25 including the step of flushing and/or aspirating before withdrawing the medical device into the retrieval catheter.

20

27. A method as claimed in claim 26 including the step of removing the centring catheter from the retrieval catheter to facilitate flushing and/or aspiration.

25

28. A method as claimed in claims 25 to 27 wherein the distal end of the centring catheter is compressed as the distal end of the centring catheter is withdrawn into the retrieval catheter.

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29. A catheter assembly comprising an inner catheter, and an outer catheter surrounding the inner catheter wherein the inner surface of the outer catheter and/or the outer surface of the inner catheter is of non-circular profile.

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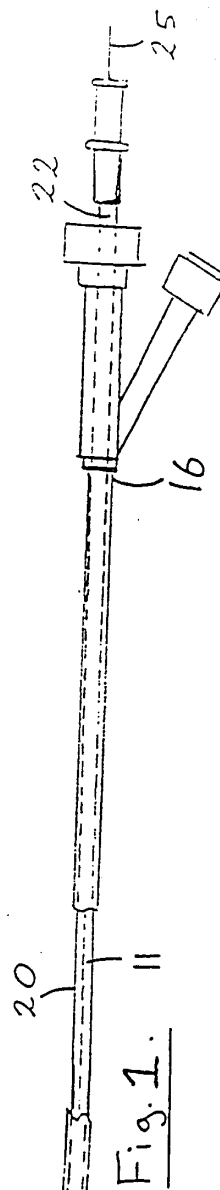
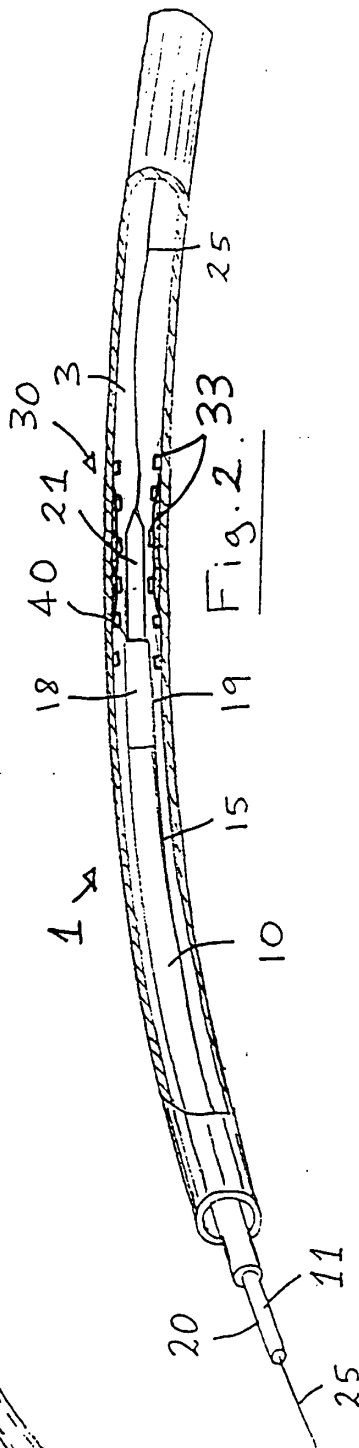
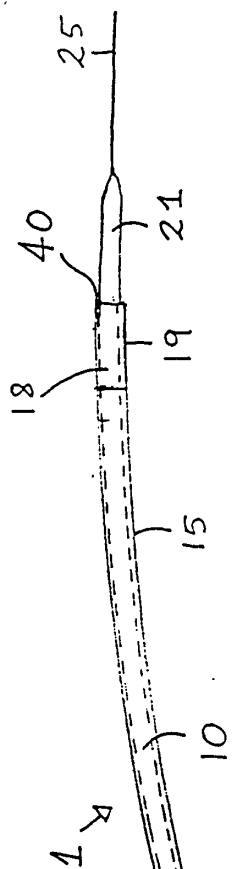
30. A catheter assembly as claimed in claim 29 wherein the catheter periphery is non-circular.
- 5 31. A catheter assembly as claimed in claim 29 or 30 wherein the catheter periphery is of oval shape.
32. A catheter assembly as claimed in claims 29 to 31 wherein the catheter periphery is shaped to define a number of separate areas of contact with the
10 other catheter.
33. A catheter assembly as claimed in claims 29 to 32 wherein the catheter periphery is of fluted shape.
- 15 34. A catheter assembly substantially as hereinbefore described with reference to the accompanying drawings.

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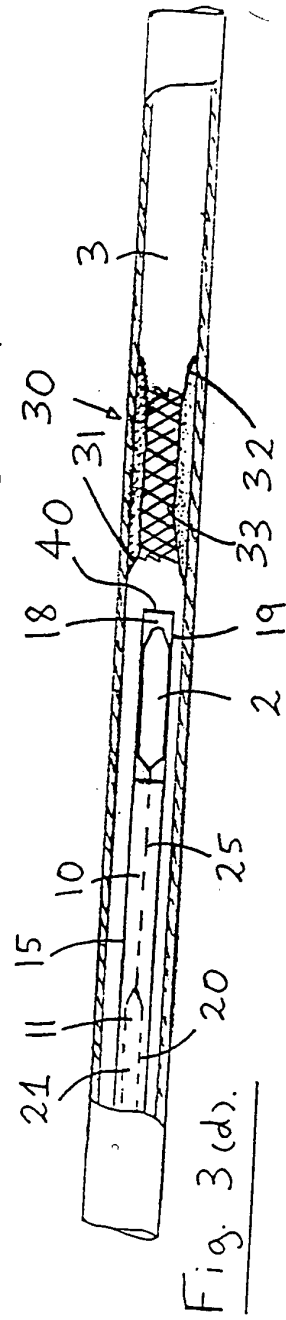
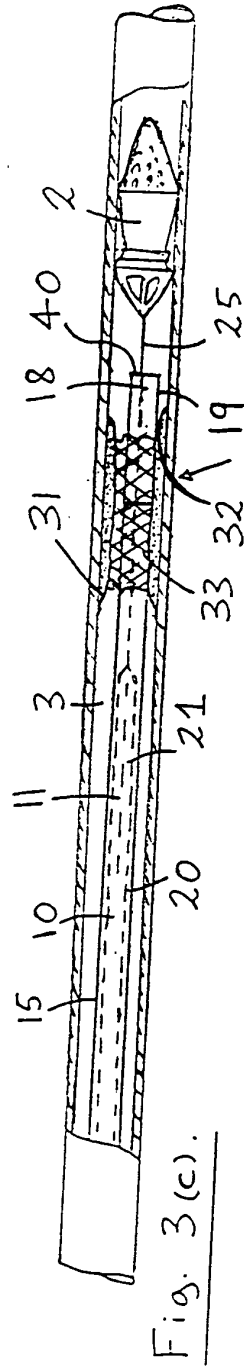
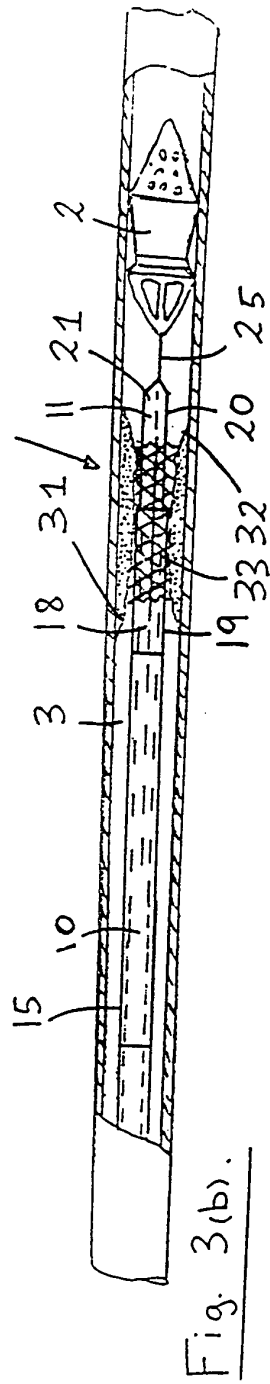
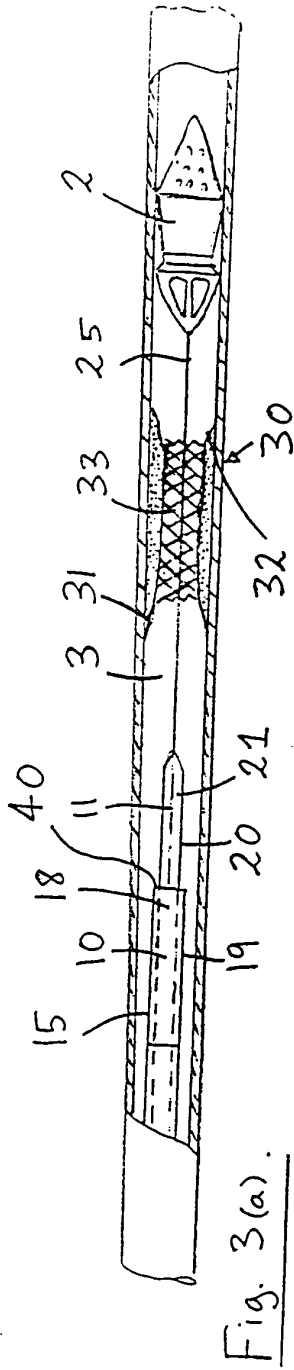
Abstract

A retrieval device 1 for retrieval of an embolic filter 2 from the vasculature 3 comprises a guide catheter 42, a retrieval catheter 10 and a centring catheter 11 which is threaded over a guidewire 25. The retrieval catheter 10 comprises an elongate flexible tube 15 including a radially expansible distal tip 19 with an open mouth 40 for retrieval of the embolic filter 2. The centring catheter 11 also comprises an elongate tube 20 which extends through the retrieval catheter tube 15 and terminates in a distal tapered end 21. The centring catheter 11 is used to centre the retrieval catheter 10 in the vasculature 3 to enable the retrieval catheter 10 to freely pass through a stenosis and/or stent to retrieve the filter 2. When the retrieval catheter 10 is in position the centring catheter 11 is withdrawn through the retrieval catheter 10.

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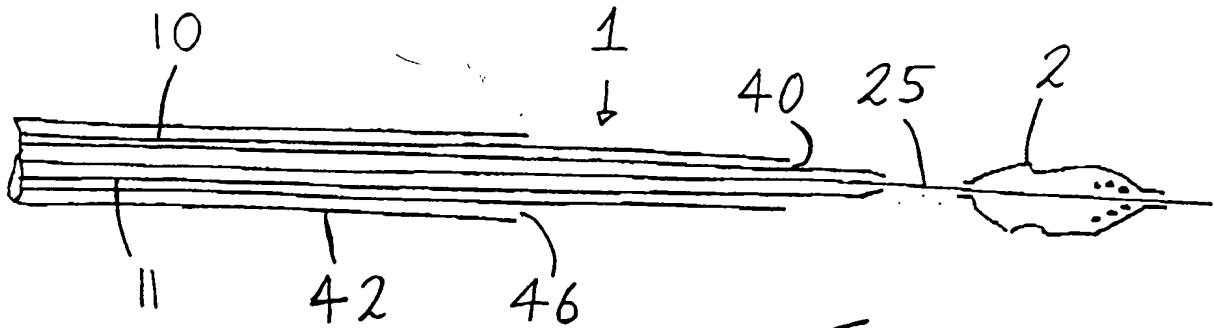


Fig. 4.

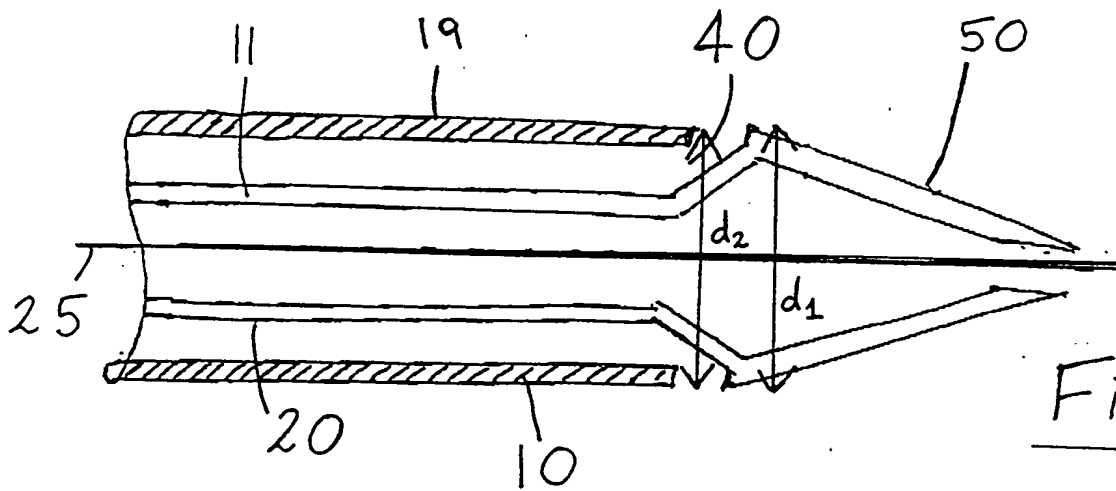


Fig. 5

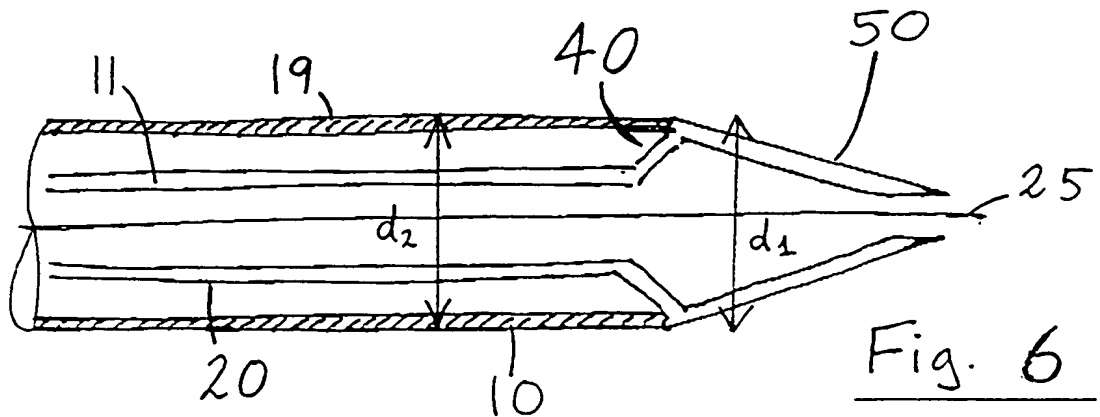


Fig. 6

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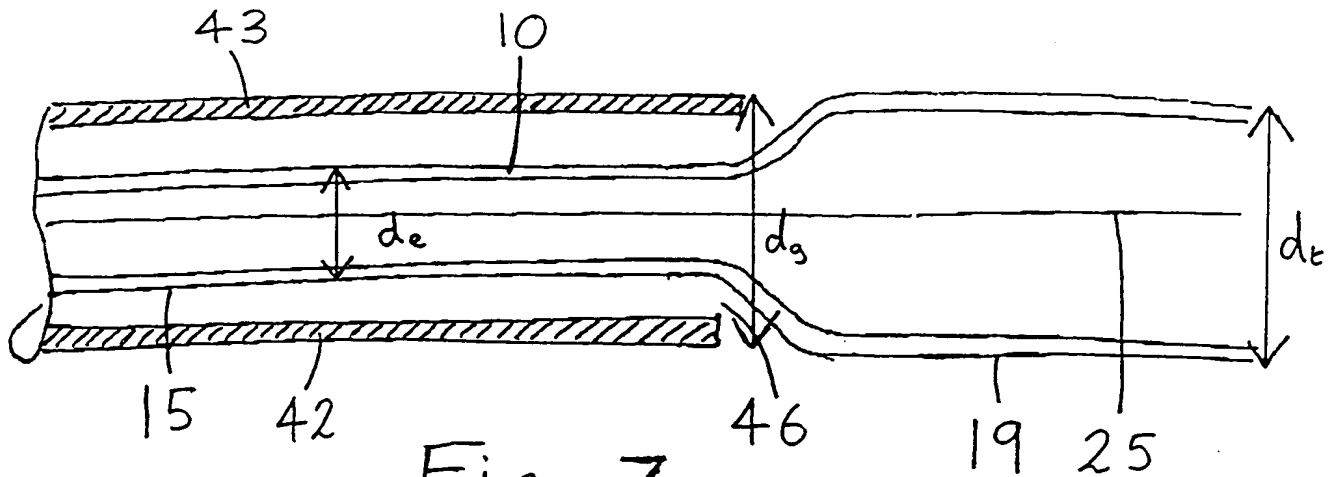


Fig. 7.

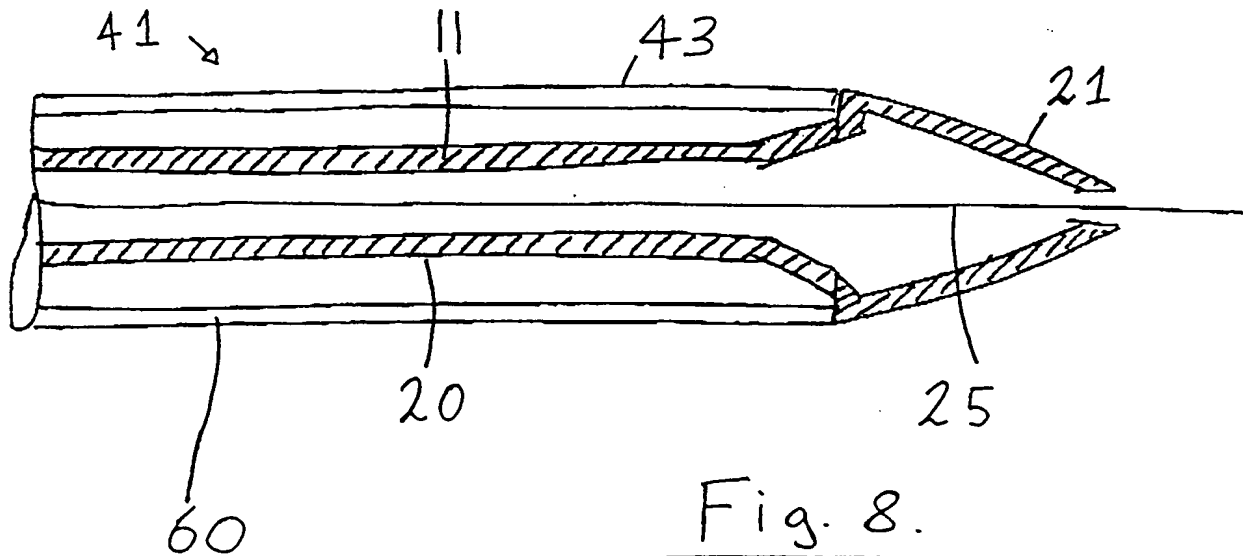


Fig. 8.

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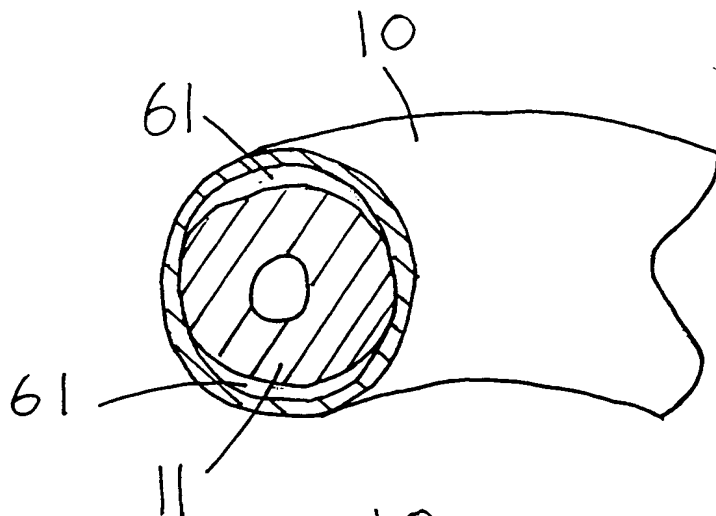


Fig. 9.

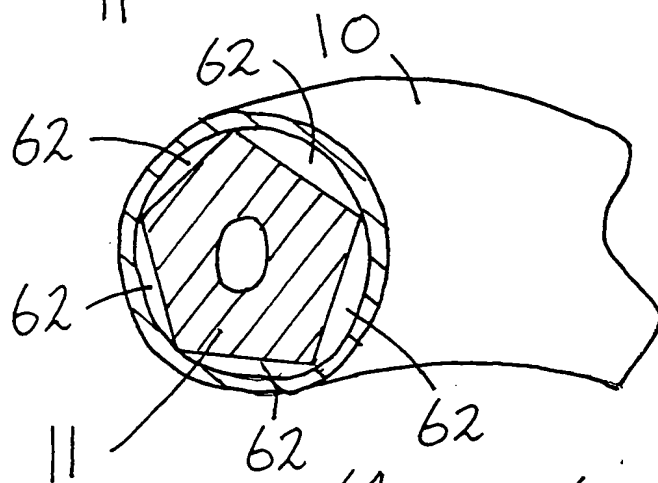


Fig. 10.

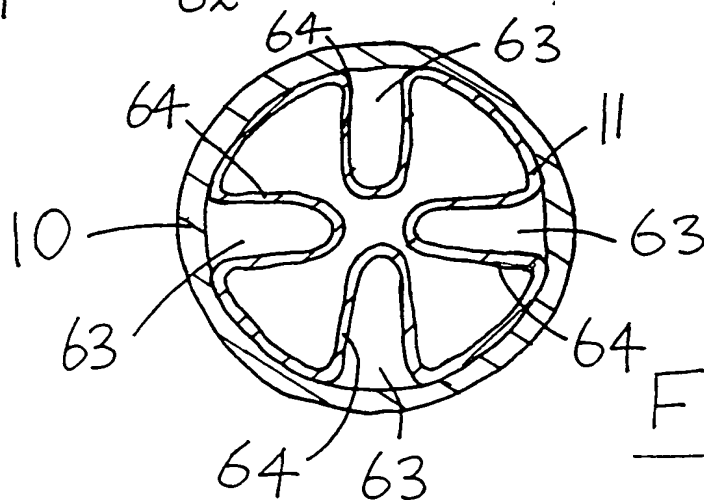


Fig. 11.